Impact of Saharan dust on tropical North Atlantic SST

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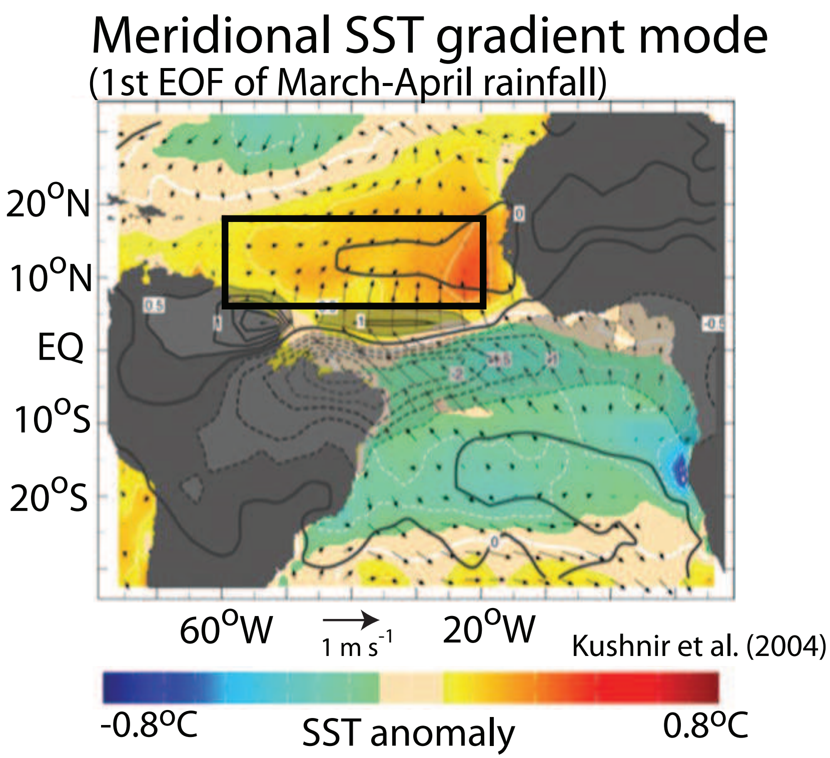
PIRATA-13 meeting; 18–20 February 2008; Natal, Brazil

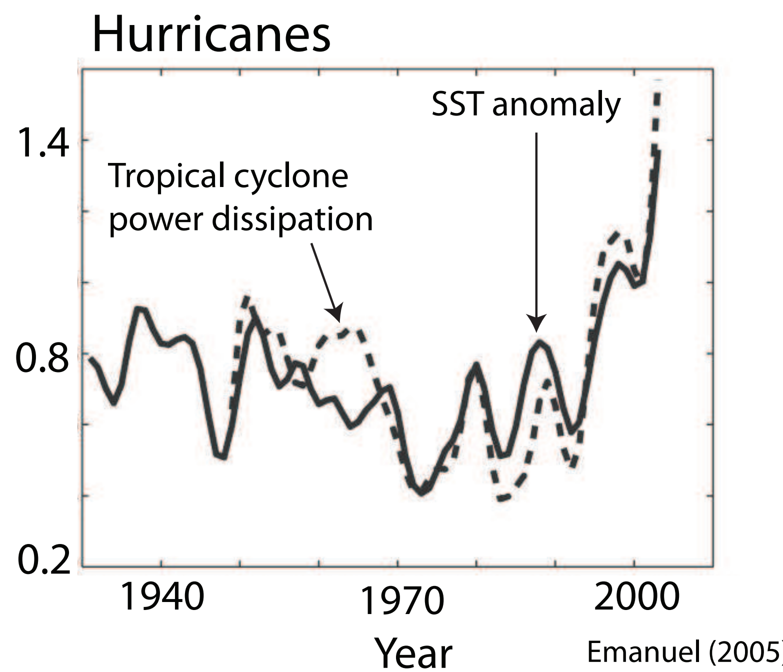
- *Purpose*: To address the recent controversy regarding the role of Saharan dust in affecting the 2005 and 2006 Atlantic hurricane seasons (Lau and Kim, 2007; Evan, 2007).

- *Approach*: Use historical data and PIRATA data to examine the processes responsible for sea surface temperature change in the main development region for Atlantic hurricanes.

Foltz, G. R., and M. J. McPhaden, 2008: Impact of Saharan dust on tropical North Atlantic SST, *J. Climate*, in revision.

Importance of tropical North Atlantic SST



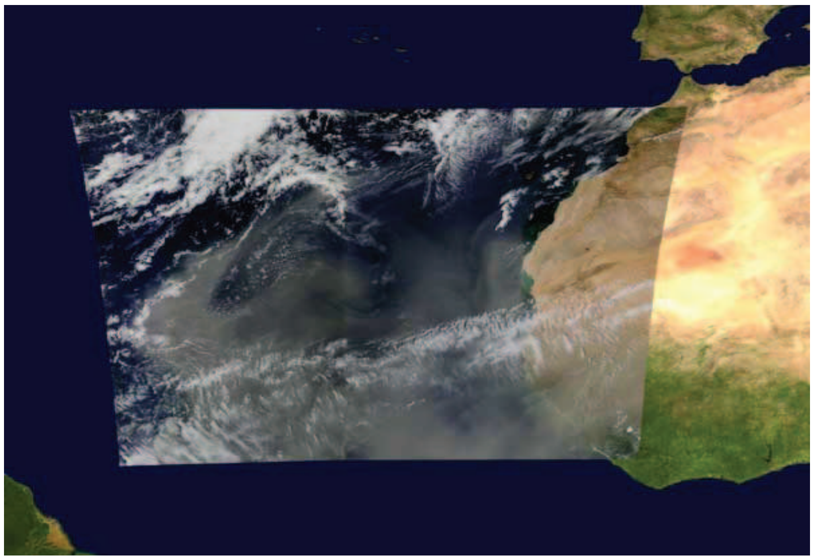


- SST gradient mode affects rainfall in Northeast Brazil and the Sahel

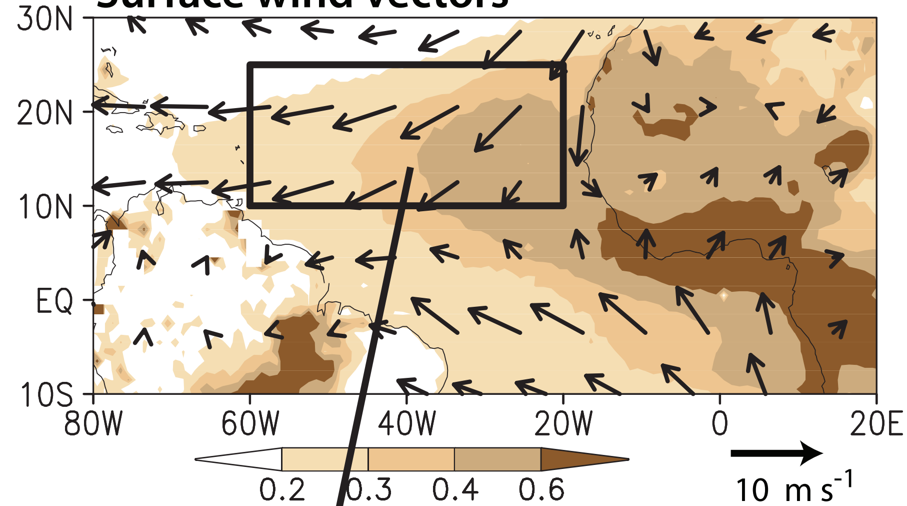
- Atlantic hurricane activity is strongly correlated with SST on interannual to decadal time scales

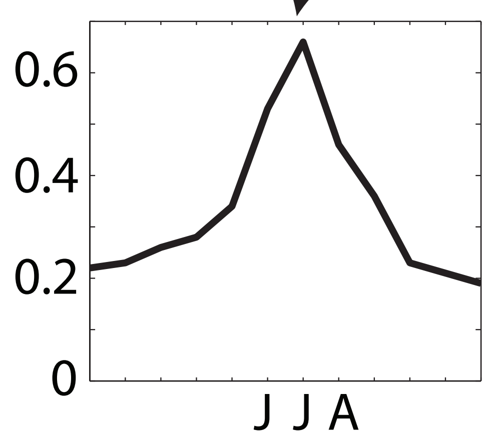
Saharan dust

MODIS (5 March 2003)



Annual mean TOMS AOD
Surface wind vectors





Seasonal cycle of AOD

- Dustiness peaks during June-August

Data: Historical analysis

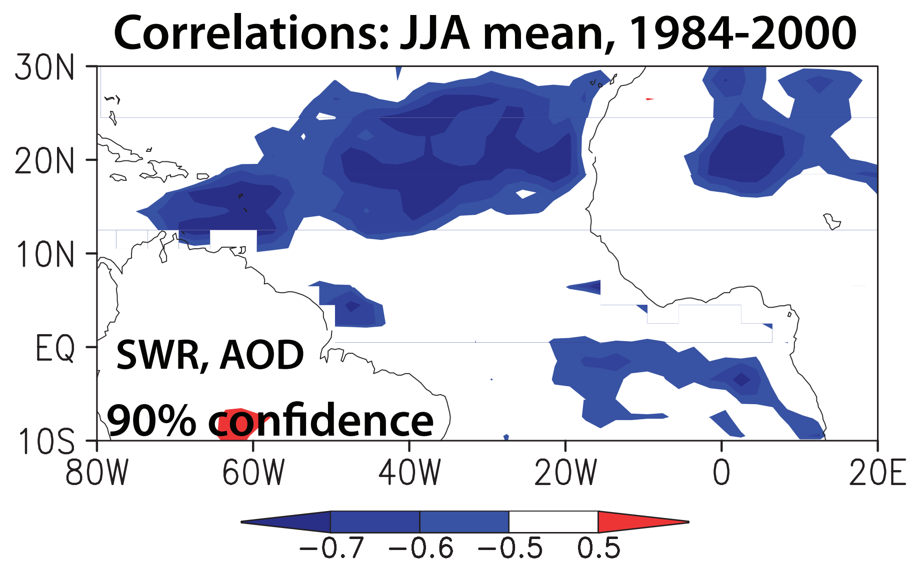
- Total Ozone Mapping Spectrometer (TOMS) aerosol optical depth (AOD)
- Satellite-based surface shortwave radiation (Zhang et al. 2004)
- Satellite-in situ SST product (Reynolds et al. 2002)
- June-August monthly means (1984-2000)

Data: Analysis for 2005–06

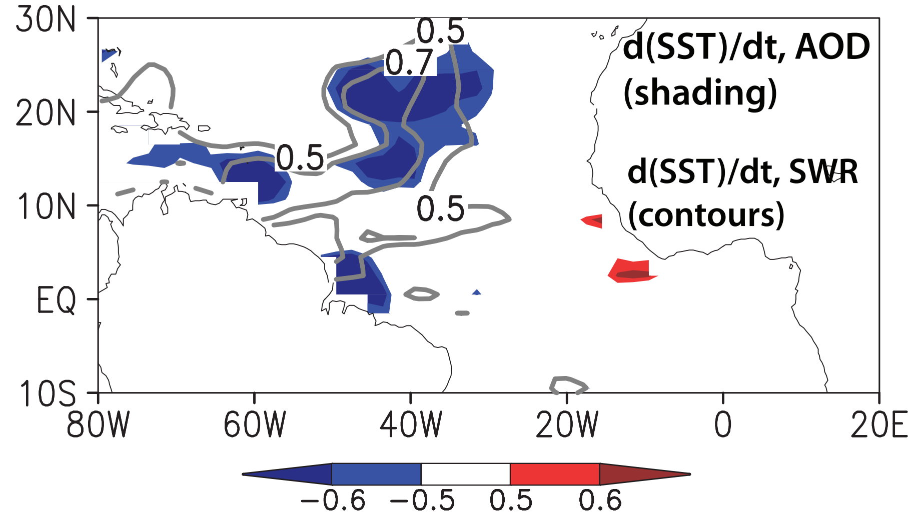
- Daily PIRATA data at 15°N, 38°W
- OSCAR currents (5-day means, averaged in upper 30 m)
- Daily TMI horizontal SST gradients
- Daily satellite (MODIS) aerosol optical depth

Impact of dust on SWR and SST

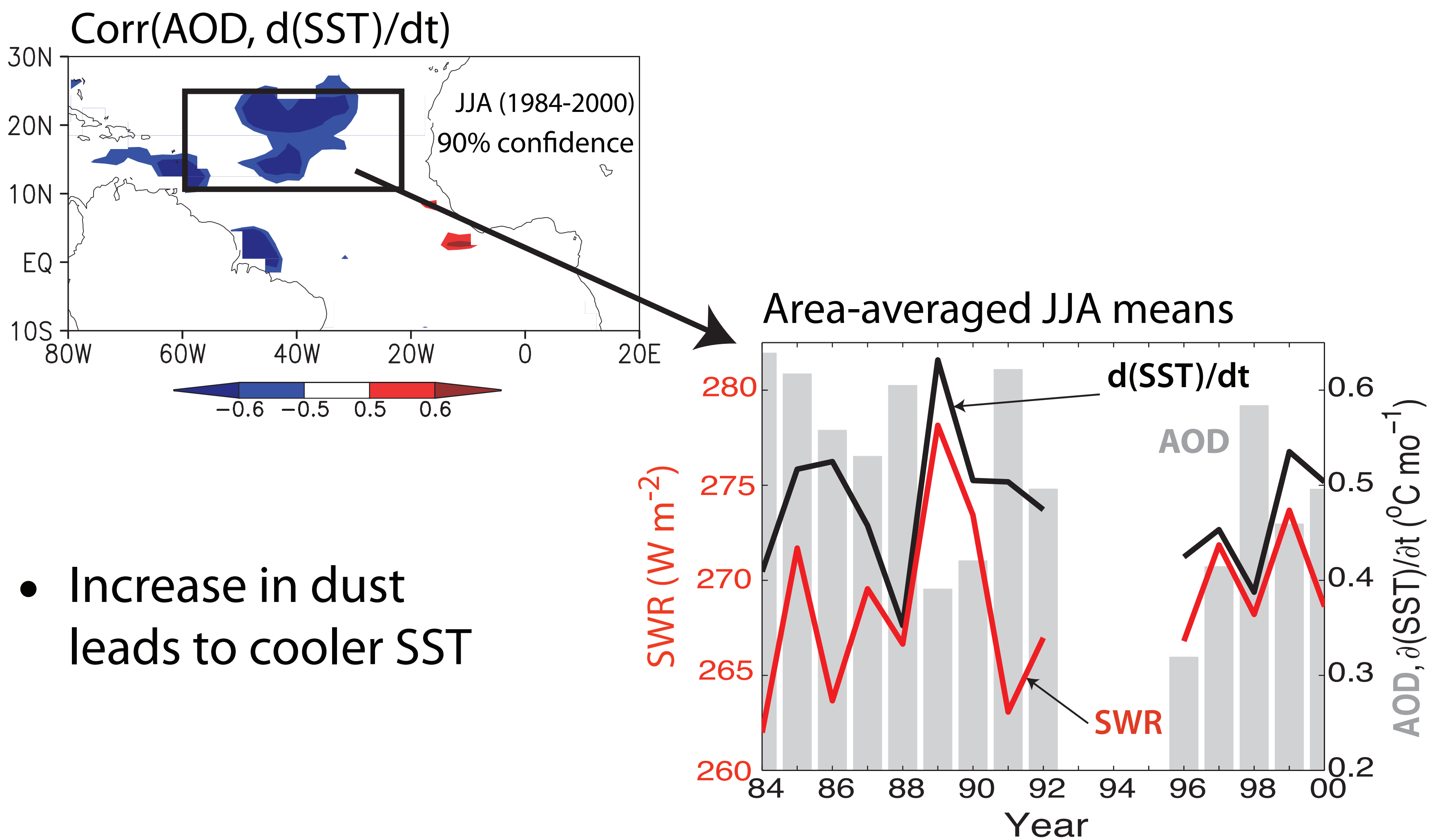
- Increase in AOD → decrease in SWR



- AOD is significantly negatively correlated with d(SST)/dt where SWR exerts the strongest influence on SST

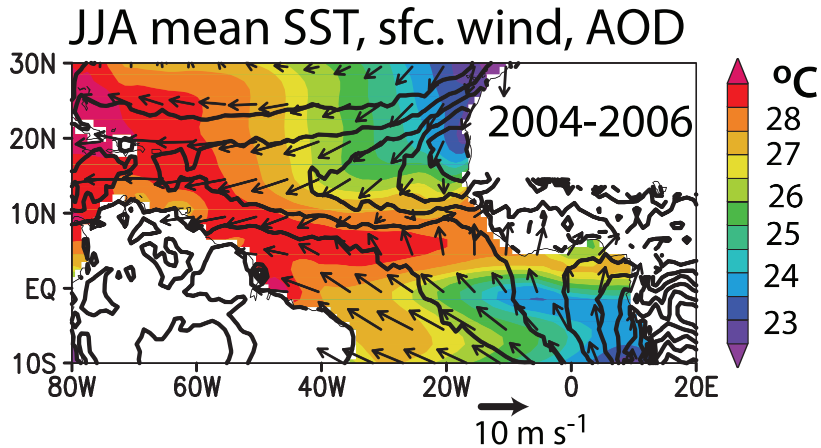


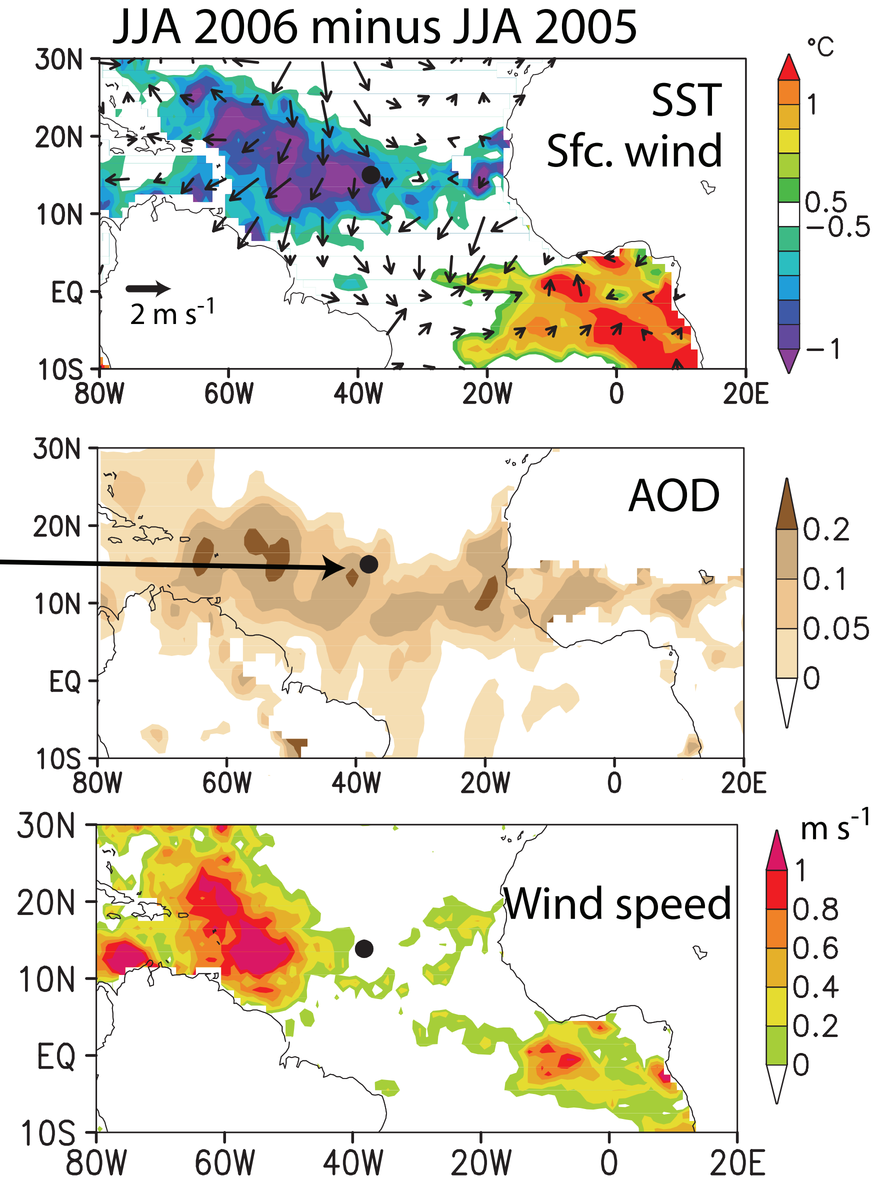
Interannual variability of dust and SST



- Increase in dust leads to cooler SST

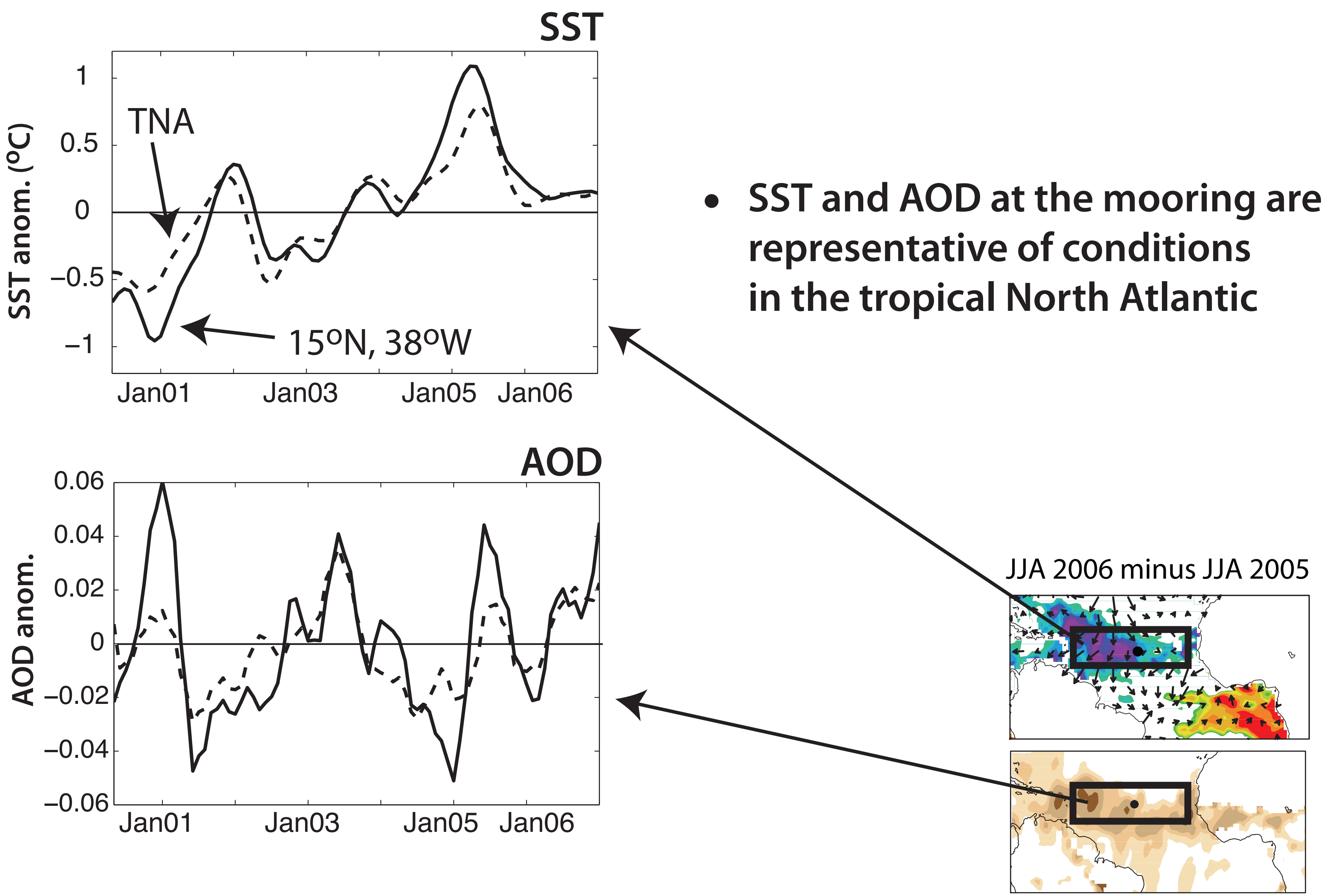
Conditions during 2005 - 2006





- Cooler SST and enhanced dust, wind speed during JJA 2006

- Did dust trigger cooling?
  (Lau and Kim, *Eos*, 2007)



- **SST and AOD at the mooring are representative of conditions in the tropical North Atlantic**

Mixed layer heat equation

Sfc. heat flux
(LHF + Abs. SWR + LWR + SHF)

Mixed layer heat storage rate

Horiz. advection

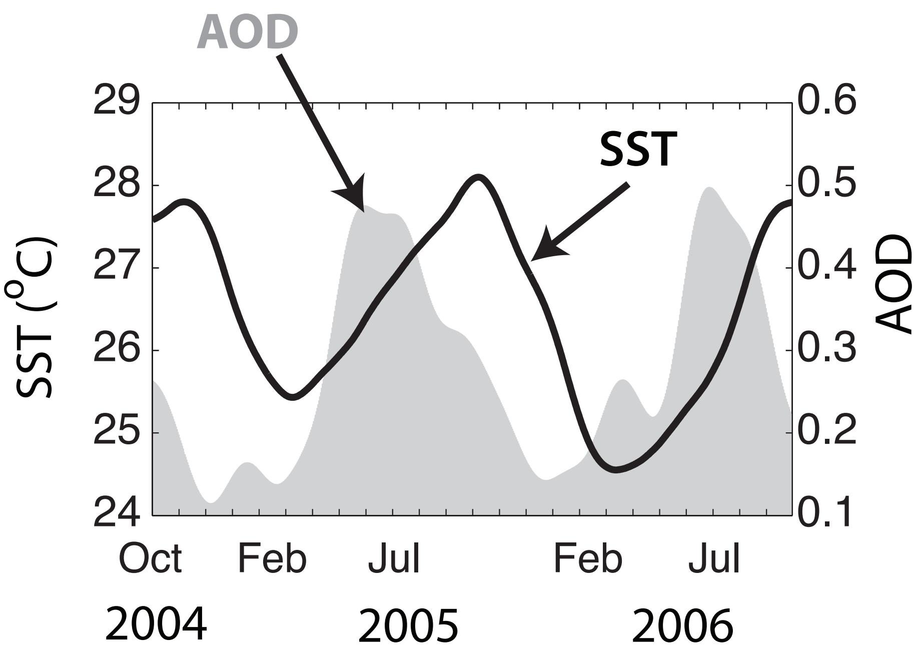
$$\rho c_p h \frac{\partial T}{\partial t} = q_0 - \rho c_p h \mathbf{v} \bullet \nabla T$$

Mixed layer depth
(0.03 kg m^{-3} criterion)

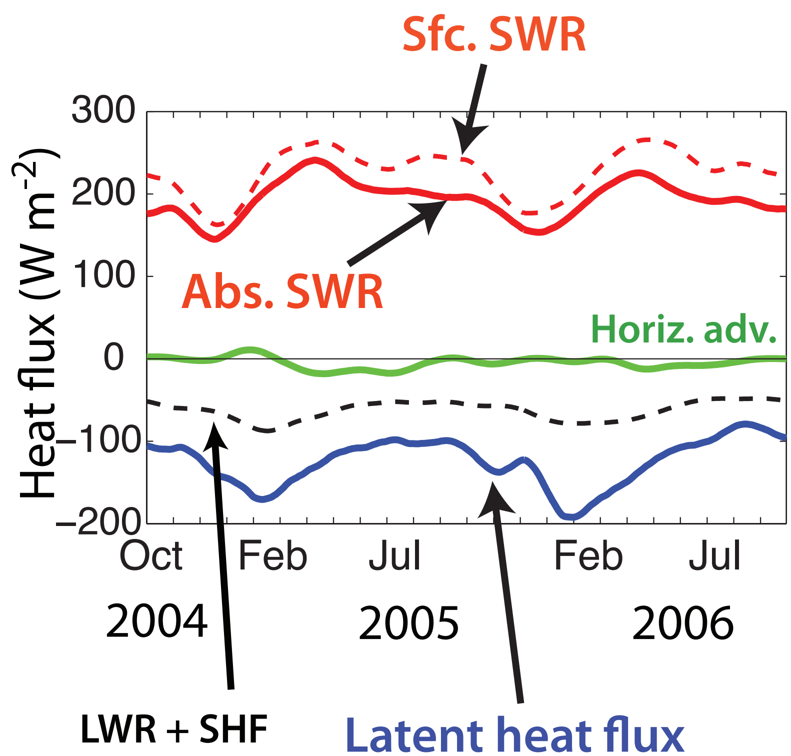
TMI SST

OSCAR currents

Conditions at the PIRATA mooring location



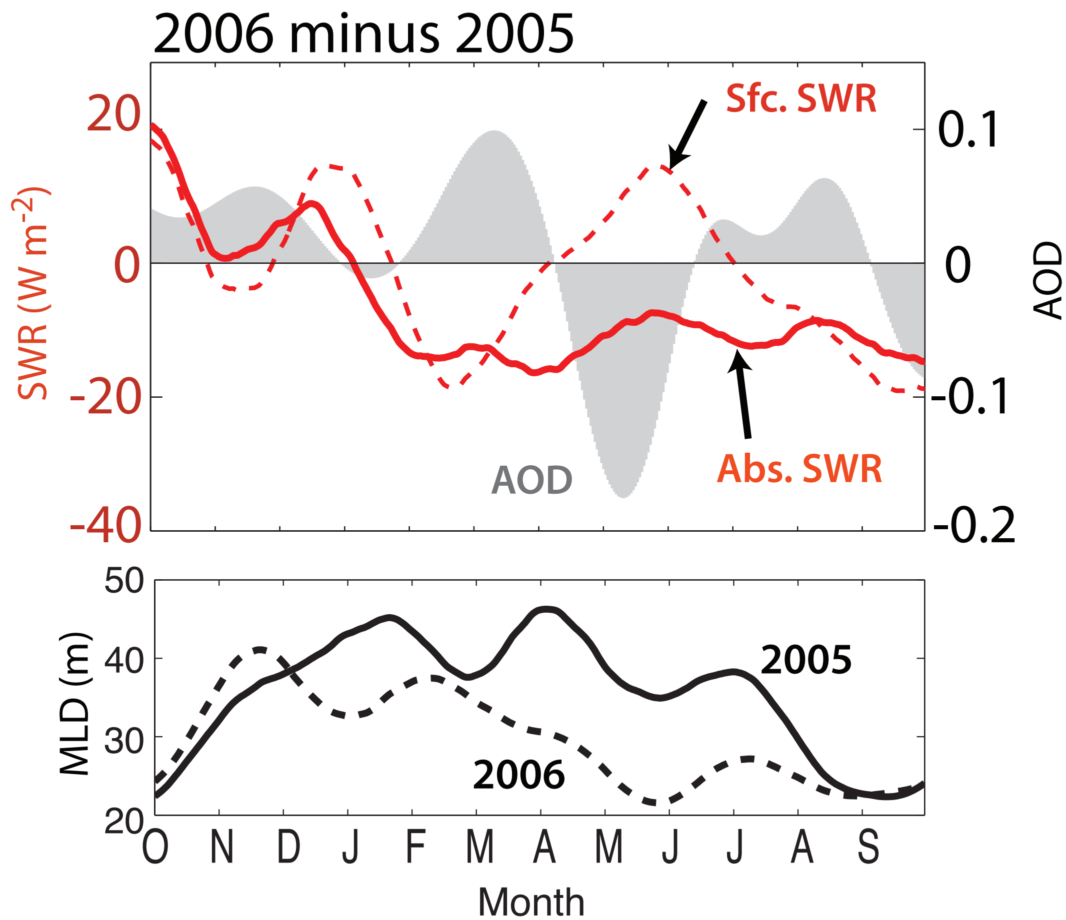
- Strong seasonal cycles for most terms
- Cooler SST during 2006

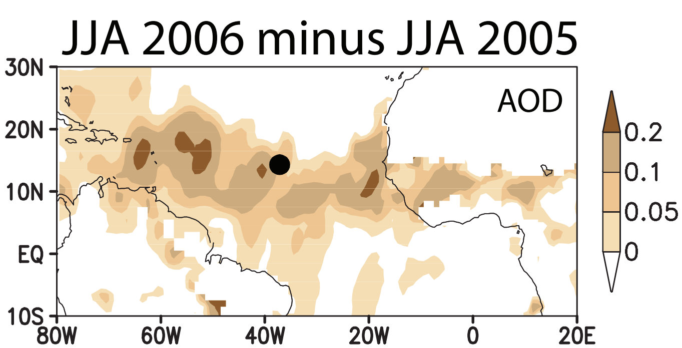


Dust and SWR at the PIRATA mooring location

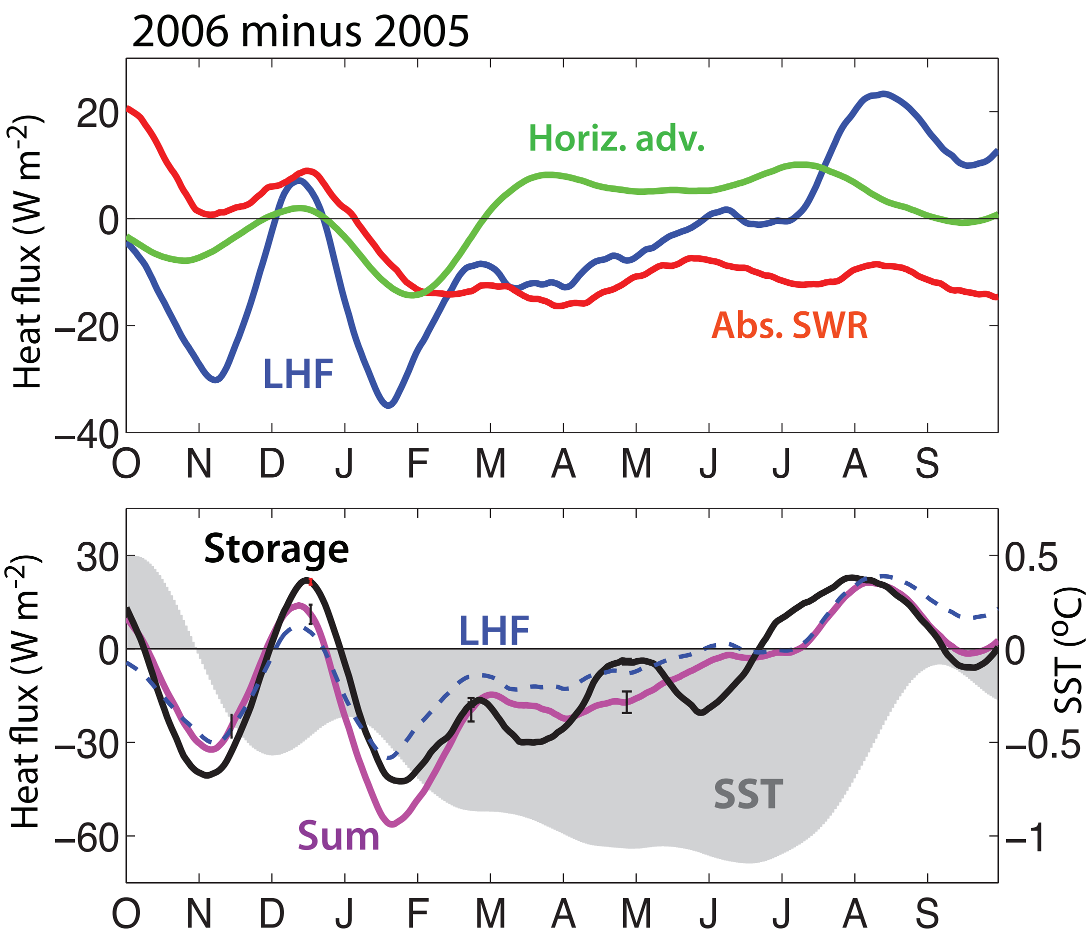
- Sfc. SWR varied out of phase with AOD

- Differences in MLD were important

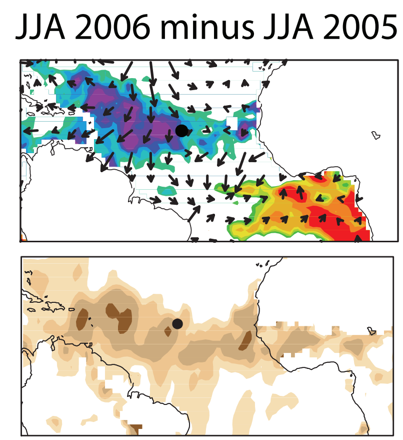




Mixed layer heat balance



- Cooling was caused primarily by wind-induced LHF



Summary

- Interannual changes in dust are significantly correlated with $\partial(SST)/\partial t$ in the central tropical North Atlantic (increase in dust $\longrightarrow$ decrease in SST).

- Cooler conditions during 2006 occurred in conjunction with enhanced atmospheric dust loading and increased wind speed.

- Anomalous cooling was primarily caused by wind-induced latent heat loss, not dust-induced SWR.

- Spatial patterns of anomalous SST and winds are suggestive of WES feedback. Did dust trigger coupled air-sea interactions?